

The Effect of Short-and Long-Term Feeding of Thyroprotein on the Performance of Lactating Dairy Cattle in Hawaii

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The activity of the thyroid affects the overall metabolism and productive performance of lactating dairy cattle. Extensive investigations conducted in the temperate zone have shown that greater milk production results when thyroxine mimetic materials or thyroxine is fed at a level exceeding the normal thyroxine output of dairy cattle (4, 11, 12, 13, 14). However, some have reported that the increase in milk production does not persist throughout the entire lactation period (8, 10, 15).

Recent data have shown that climatic conditions influence the thyroid activity of dairy cattle. These data suggest that the climatic conditions of tropical and subtropical regions reduce the activity of the thyroid. Blincoe and Brody (5) reported that increasing the ambient temperature above the comfort zone to 95°F decreased the thyroid activity 30 to 65 percent in four breeds of cows studied. Holsteins had the greatest decrease and Brahmans the least. Johnson and Ragsdale (7) reported that the thyroid activity of dairy heifers correlates negatively with temperature. Measurements were made of the I^{131} release rate from the thyroid. As the environmental temperature increased from 35° to 80°F, there was a gradual decrease in the thyroid I^{131} release rate. Above 80°F, there was a sharp decline in I^{131} activity. In a recent publication, the Missouri workers concluded that the thyroid activity is depressed by high environmental and body temperature (9).

High temperatures may also affect the rumen metabolism of lactating dairy cattle and thus influence the production of the animal. One of the rumen metabolites, acetic acid, is known to be a precursor for milk fat synthesis (3). Weldy *et al.* (16) reported that total volatile fatty acids in the rumen were lower at 90°F than at 35 to 78°F, the prevailing ambient conditions. The lowered acetic acid content was largely responsible for lowering the total volatile fatty acid content. These data suggest that high environmental temperatures could reduce the ruminal acetate level and thus affect the quantity of milk fat synthesized.

It has been reported that the activity of the thyroid is also involved in rumen metabolism and milk fat synthesis. Azimov (2), using goats as experimental animals, reported that blocking the thyroid caused a depression in the acetate content of the rumen along with a decrease in the fat content of the milk. Injecting thyroxine caused a substantial increase in the fat content of the milk and the proportion of ruminal acetate was raised at the expense of butyrate. This observation has been substantiated by researchers who have reported that thyroprotein feeding not only increases milk production but also causes an increase in the fat content of the milk produced (2, 6, 14).

The fact that high environmental temperatures reduce the activity of the thyroid (5, 7, 9) and thyroid activity affects rumen metabolism (2) indicates that environment, mediated through the thyroid gland, is perhaps responsible for the production of low fat milk.

Hawaii has a climate that may cause reduced thyroid activity. The two trials reported herein were conducted to evaluate the effect of feeding thyroprotein to lactating dairy cattle for a short period of 6 weeks and for a longer period of 6 months.

EXPERIMENTAL PROCEDURE

The animals used were 20 lactating Holstein cows at the University of Hawaii Agricultural Experiment Station Research Farm at Waialeale, Oahu. Animals were placed on trial after they had calved and had been in production for 2 to 3 months. Two trials were conducted. In each trial, animals were randomly assigned to two groups of five cows per group. Cows in group 1 served as control and cows in group 2 received the thyroprotein.

The roughage fed during each experiment was 14 pounds of pineapple bran per cow daily. The concentrate mixture shown in table 1 was fed in excess of the amount each cow would consume during two 1-hour feeding periods daily. Concentrate was fed in this manner in order to allow the animals to consume as much as they wanted. At the time the concentrate was fed, thyroprotein¹ was added to the first 2 pounds of concentrate fed.

¹The thyroprotein fed in these trials was Protomone, provided without charge by Agri-Tech., Inc., Kansas City, Missouri.

After this was consumed, additional concentrate was fed. Animals in trial 1 were fed daily 1.12 grams of thyroprotein per 100 pounds of body weight and animals in trial 2 received 0.95 gram of thyroprotein per 100 pounds of body weight. The body weights used in establishing the amount of thyroprotein to be fed were weights taken during the initial week of the trial.

During the first 5 weeks of the trial (standardization period), all animals received the control treatment. Data from the last 3 weeks of the standardization period served as a base period for the cows. Animals were then placed on either control or thyroprotein treatment for 6 weeks (trial 1) or 6 months (trial 2). In trial 1, thyroprotein feeding was discontinued after 6 weeks and the animals were observed for the remainder of their lactations.

During these trials, a daily record of milk production was maintained. Weekly milk samples were collected from four consecutive milkings throughout trial 1 and during the standardization period in trial 2. For the remainder of trial 2, milk samples were collected monthly. Milk samples were analyzed for fat using the Babcock method and analyzed for total solids and protein using the procedure outlined by the Association of Official Agricultural Chemists (A.O.A.C.) (1). Body weights and rectal temperatures were obtained in both trials. Body weights were taken for 3 consecutive days after morning feeding and before the animals had access to water at the beginning and end of each experimental period. Rectal temperatures were taken once a week beginning at approximately 10:00 a.m. throughout trial 1 and during the standardization period in trial 2. Monthly recordings were taken for the remainder of trial 2. A record of the amount of feed offered was maintained for both trials. A record of the feed not consumed was maintained for trial 1.

All data were analyzed by covariance analysis with reference to the animals' performance during the base period.

TABLE 1. Concentrate Ration

INGREDIENT	POUNDS
Molasses	100
Barley	280
Millrun	100
Coconut oil meal	250
Soybean oil meal	250
Trace mineralized salt	10
Dicalcium phosphate	10
Vitamin A (30,000 units/g.)	0.33

RESULTS AND DISCUSSION

Milk production, milk composition, and amount of milk constituents produced daily are shown in table 2. In trial 1, the dairy cattle fed thyroprotein produced significantly more milk and 4-percent fat-corrected milk (4% FCM) daily than did the control-fed animals. For the 6-week period, the thyroprotein-fed animals produced 32.7 percent more milk and 29.3 percent more 4% FCM daily than did the control-fed animals. The fat, total solids, and solids-not-fat content of the milk were not significantly different for the two treatments. These data are not in agreement with reports that thyroprotein causes a significant increase in milk fat content (2, 6, 14). Feeding thyroprotein did cause a significant decrease in the protein content of the milk as compared with milk from the control animals.

In trial 1, milk constituents produced daily (fat, total solids, solids-not-fat, and protein) were all significantly higher for the thyroprotein-fed animals. This was the result of increased milk production and not of change in the composition of milk from thyroprotein-fed animals.

In trial 2 (see table 2), the differences in milk production, milk composition, and milk constituents produced daily between the control and the thyroprotein-fed animals were not statistically significant. Even though these differences were not significant, trends were indicated. Mean values shown in table 2 clearly show a trend toward lower milk production and milk constituents produced daily for the animals fed thyroprotein for 6 months. Thyroprotein-fed animals in this trial produced 9.1 percent less

TABLE 2. Milk production, milk constituents, and milk constituents produced daily

Items	Trial 1 (6 weeks)		Trial 2 (6 months)	
	Control	Thyroprotein	Control	Thyroprotein
Production (lbs.)				
Milk	37.9 **	50.3	38.4	34.9
4% FCM	38.2 **	49.4	35.3	30.9
Milk constituents (%)				
Fat	4.14	3.98	3.35	3.40
Total solids	13.29	13.16	11.95	11.91
Solids-not-fat	9.17	9.09	8.53	8.55
Protein	3.65*	3.39	3.42	3.35
Milk constituents (lbs.)				
Fat	1.54**	1.94	1.30	1.15
Total solids	5.02*	6.69	4.65	4.10
Solids-not-fat	3.48**	4.67	3.31	2.95
Protein	1.37**	1.68	1.32	1.17

* Significantly different ($P=0.01$)

** Significantly different ($P=0.05$)

milk and 12.4 percent less 4% FCM than did the control-fed animals. Also the daily production of milk constituents (fat, total solids, solids-not-fat, and protein) was from 11 to 12 percent less for the thyroprotein-fed animals than for the control animals. The composition of the milk produced was similar for the two treatments.

The data presented thus far show the effect of short- and long-term feeding of thyroprotein. Additional information is given in figures 1 and 2. These figures show the average daily milk production plotted at weekly intervals for the complete lactation (46 weeks) for both trials. In trial 1 (figure 1), animals peaked in production 4 to 6 weeks after calving and began the trial on the 11th week at an average production of approximately 47 pounds of milk daily. Data were collected during the 13th to 16th week for the standardization period. During this time, both groups were producing at approximately the same level. Thyroprotein was fed from the 18th to the 24th week. The control animals decreased in milk production from approximately 44 pounds at the 18th week to 36 pounds at the 24th week; the animals fed thyroprotein increased in milk production from 44 pounds at the 18th week to 56 pounds at the 20th week, then decreased to 45 pounds at the 24th week. Two weeks after removing the thyroprotein from the ration (26th week), the thyroprotein-fed animals were producing approximately 5 pounds less milk daily than the controls and continued to produce approximately 5 pounds less daily than the controls for the remainder of their lactations.

Figure 2 shows the average daily milk production for animals receiving thyroprotein for 6 months. Animals peaked in production at approximately 6 weeks and were placed on trial at 11 weeks after calving. The average production level at 11 weeks was 62 pounds per cow per day. Data for the base period were collected during the 13th to 16th week. Thyroprotein feeding began at the end of the 16th week and continued for 6 months.

Feeding 0.95 grams of thyroprotein per 100 pounds body weight did not elicit the response observed when animals received 1.12 grams of thyroprotein per 100 pounds body weight (see figure 1). From 16 to 21 weeks, the thyroprotein-fed animals produced an average of only 3.12 pounds more milk daily than the controls. By the 25th week, the thyroprotein-fed animals were producing 10 pounds less milk daily than the controls. During the remainder of the lactation, the thyroprotein-fed animals produced at a level of 10 to 12 pounds less daily than the control animals.

The data presented in table 2 and figures 1 and 2 show that a significant increase in milk production was obtained when 1.12 grams of thyroprotein per 100 pounds of body weight was fed for a short period (6 weeks). However, a lesser increase in production was obtained when 0.95 gram of thyroprotein per 100 pounds of body weight was fed, and this slight increase was maintained for only 5 weeks even though thyroprotein was fed for an extended period (6 months). After withdrawal of thyroprotein in trial 1

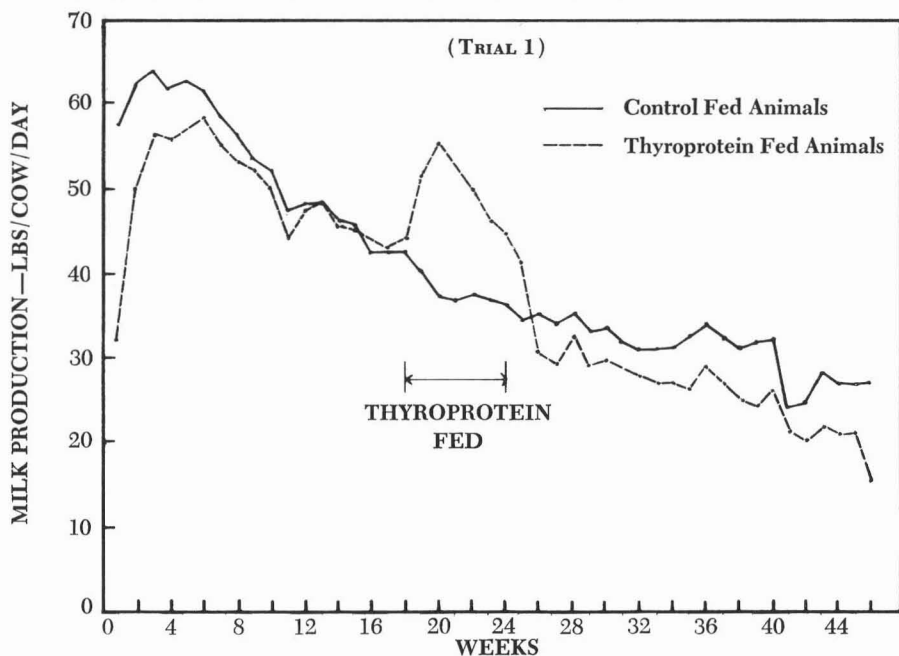


FIGURE 1. Average daily milk production for control and thyroprotein-fed animals.

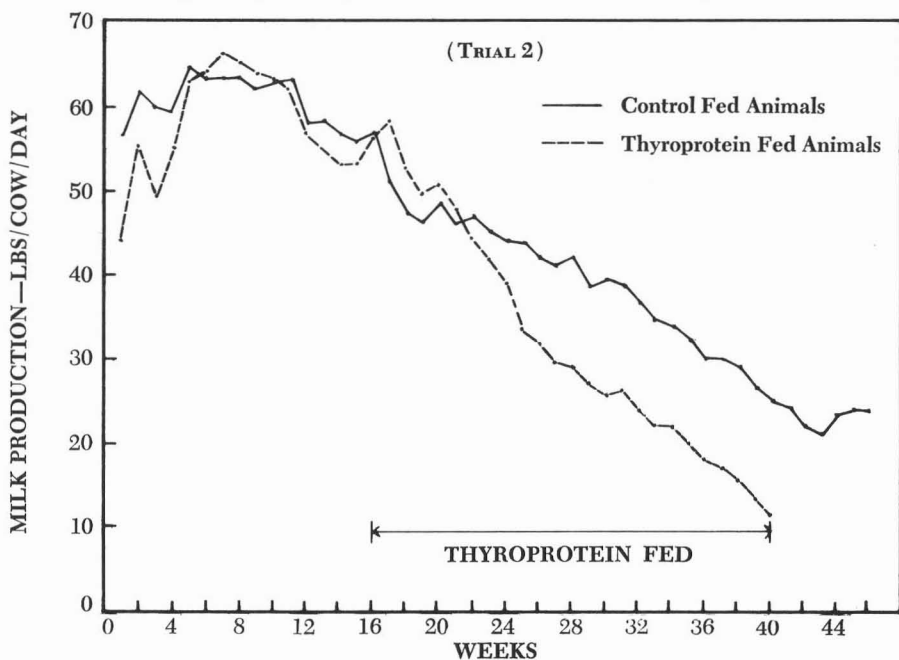


FIGURE 2. Average daily milk production for control and thyroprotein fed animals.

and after 6 weeks feeding in trial 2, the thyroprotein-fed animals were producing below the level of the control animals. Results from these trials show that greater depression in milk production occurred in trial 2 when thyroprotein was fed for 6 months than in trial 1 when thyroprotein feeding was discontinued after 6 weeks. The advantage in milk production of the control animals over the thyroprotein-fed animals from the 26th to the 46th week of lactation in trial 1 was approximately 5 pounds, whereas in trial 2 the advantage was 10 to 12 pounds. Milking of four of the five cows on thyroprotein in trial 2 was discontinued on the 40th week because of very low production. Apparently the combined stress of climatic conditions plus the metabolic stress of feeding thyroprotein caused a larger drop in milk production when thyroprotein was fed for a 6-month period than when thyroprotein was discontinued after 6 weeks.

TABLE 3. Feed consumption (trial 1)

Treatment	Concentrate	Pineapple bran
	lbs. daily D.M. basis	
Control	17.5	12.8
Thyroprotein	16.1	12.7

Feed consumption data for trial 1 are presented in table 3. There were no significant differences in the amounts of either concentrate or pineapple bran consumed. The increase in production associated with feeding thyroprotein requires that additional feed be consumed. Other researchers have established that an increase in feed consumption (about 4 pounds of concentrate daily) is required to compensate for the increased metabolic rate and production resulting from thyroprotein feeding (4, 10, 11, 13). Although the animals in these trials were fed all the concentrate they would consume during two 1-hour feeding periods daily, the thyroprotein-fed animals consumed slightly less concentrate than the control animals.

Body weight losses and rectal temperatures were significantly higher for the thyroprotein-fed animals in both trials, as compared with the controls. Thyroprotein-fed animals lost slightly more than 200 pounds body weight and had rectal temperatures 1°F higher than did the control animals. Both of these factors, i.e., loss of body weight and elevated rectal temperatures, indicate a stress condition.

General observations of the animals throughout the trials indicated that milk production was maintained until the animals had lost considerable body weight. The thyroprotein feeding stimulated greater milk production, and this higher milk production was maintained only as long as the animals maintained a reasonable body condition.

While trial 1 showed that increased milk production was possible when 1.12 grams of thyroprotein per 100 pounds of body weight was fed for a short period, the thyroprotein-fed animals produced approximately 5 pounds less milk per cow per day than the controls after the thyroprotein feeding was discontinued. Further, feeding thyroprotein at a level of 0.95 gram per 100 pounds body weight for 6 months caused only a slight rise in milk production, followed by a large depression in milk production after 6 weeks of thyroprotein feeding. Also, thyroprotein-fed animals lost significantly more body weight and had significantly higher rectal temperatures, which indicated a stress condition.

SUMMARY

Two trials using five control and five treatment animals per trial were conducted feeding 1.12 grams of thyroprotein (Protomone) per 100 pounds of body weight for 6 weeks (trial 1) and feeding 0.95 gram of thyroprotein per 100 pounds of body weight for 6 months (trial 2). Animals went on trial after being in production from 2 to 3 months. Treatments were continuous after a 5-week standardization period.

Roughage was fed at the rate of 14 pounds of pineapple bran daily. Animals were fed all the concentrate they would consume during two 1-hour feeding periods daily. Thyroprotein was added to the concentrate ration and fed once daily.

Data were analyzed by covariance with reference to the animals' performance during the standardization period. Average milk production for each group of cows within each trial was determined at weekly intervals throughout the lactation in order to study the effect of complete withdrawal of thyroprotein after 6 weeks feeding in trial 1, as compared with feeding thyroprotein for 6 months in trial 2.

When evaluated for a 6-week period (trial 1), the thyroprotein-fed animals produced significantly more milk and 4-percent fat-corrected milk daily than did the controls. The protein content of the milk was significantly lower for the thyroprotein-fed animals. The daily production of total solids, fat, solids-not-fat, and protein were significantly higher for the thyroprotein-fed animals because of the greater volume of milk produced.

When evaluated for a 6-month period (trial 2), there were no significant differences in the productive performance of the two groups of animals. However, a trend toward lower production of milk and milk constituents was observed in the thyroprotein-fed animals.

Milk production data plotted for the complete lactation showed that feeding 1.12 grams of thyroprotein per 100 pounds body weight increased milk production. However, after removing the thyroprotein from the ration, the cows produced approximately 5 pounds less than the controls. In trial 2, feeding 0.95 gram of thyroprotein per 100 pounds body weight caused

only a slight increase in milk production, and this increase was sustained for only 6 weeks even though thyroprotein feeding was continued. For the remainder of the lactation, the thyroprotein-fed animals produced approximately 10 pounds less milk than the controls.

In both trials, thyroprotein-fed animals lost significantly more body weight and had significantly higher rectal temperatures. Both of these factors suggest a stress condition.

These data indicate that approximately 1 gram of thyroprotein per 100 pounds of body weight would be required to stimulate production and that this amount would probably cause a stress condition in the animals.

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